g. Barry

1979 DOUGLAS-FIR TUSSOCK MOTH SUPPRESSION PROJECTS

SANTA FE NATIONAL FOREST
ELLENA GALLEGOS GRANT

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FOREST INSECT AND DISEASE MANAGEMENT • STATE AND PRIVATE FORESTRY
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1979 DOUGLAS-FIR TUSSOCK MOTH SUPPRESSION PROJECTS

Santa Fe National Forest
and
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CONTENTS

I. INTRODUCTION

The Douglas-fir tussock moth, Orgyia pseudotsugata McD., is a destructive defoliator of coniferous forests in western North America. This insect periodically reaches epidemic levels causing heavy defoliation resulting in the top-kill and death of many trees and the weakening of many others (Wickman et al. 1973).

The first reported tussock moth outbreak in the Southwest was discovered in 1957 on the Pinal Mountains, Tonto National Forest, Arizona. Within a year, three new infestations were detected: Baker Mountains, Tonto National Forest; Capitan Mountains, Lincoln National Forest, and Sandia Mountains, Cibola National Forest (Yasinski 1960). These outbreaks persisted from 1957 to 1960, when the areas were treated with DDT. Natural populations recurred at epidemic levels in these same areas from 1967 to 1970 (Lessard 1975).

Observation of the tussock moth attacking ornamental fir and spruce trees in the Southwest first took place in the northeast section of Santa Fe, New Mexico in 1966. By 1968, infestations were also detected on ornamental trees in Los Alamos and Ruidoso, New Mexico (Lessard 1975). In 1977, a coordinated spraying effort eliminated the moths from Ruidoso. The infestation in Santa Fe, New Mexico, has persisted at low to moderate levels since being detected.

Light defoliation caused by the Douglas-fir tussock moth was observed in 1976 on forested land in two canyons which dissect the townsite area of Los Alamos, New Mexico. By 1977, light to complete defoliation had occurred on 1,200 acres of mixed conifer type in these canyons. A new biological insecticide consisting of the Douglas-fir tussock moth nucleopolyhedrosis virus was pilot tested in these canyons in June 1978. This pilot project was successful in reducing tussock moth populations and demonstrated that the virus could be used effectively in the Southwest (Hofacker et al. 1979). Concurrent with the pilot test, the application of carbaryl by hydraulic sprayer to 1,900 individual ornamental trees reduced the infestation in the Los Alamos townsite to an innocuous level.

In 1978, a Douglas-fir tussock moth outbreak appeared on private land in Bear Canyon, on the west side of the Sandia Mountains, near Albuquerque, New Mexico; an incipient infestation was also detected west of the townsite of Los Alamos, New Mexico, on the Santa Fe National Forest. In 1979, the Douglas-fir tussock moth nucleopolyhedrosis virus was selected to suppress these infestations.

II. OBJECTIVE

The objective of these 1979 Douglas-fir tussock moth suppression projects was to reduce tussock moth populations, and thereby reduce tussock moth-caused tree mortality, maintain recreational and aesthetic values, and reduce wildfire hazards.

III. METHODS

A. The Treatment Areas

1. Bear Canyon

This 600-acre area is located 15 miles northeast of the city center of Albuquerque, New Mexico, within the boundary of the Ellena Gallegos Grant on the west side of the Sandia Mountains (Fig. 1). The canyon is oriented west to east, terminating at the base of the mountain crest, with elevation ranging from 7,000 to 8,500 feet m.s.l. Ownership of the area is private.

2. Los Alamos

The 800-acre infested area is on the Santa Fe National Forest, adjacent to the western boundary of the townsite of Los Alamos (Fig. 2); the elevation ranges from 7,400 to 8,300 feet m.s.l. A small portion of the area was on land administered by the General Services Administration.

B. The Pesticide

The pesticide applied to the infested areas of Bear Canyon and Los Alamos was TM-Biocontrol-1, a Douglas-fir tussock moth nucleopolyhedrosis virus preparation (DFTM-NPV) registered for use against the tussock moth in 1976.

The DFTM-NPV effects are specific to the Douglas-fir tussock moth and some other closely related species of tussock moth; no adverse effects on non-target organisms have been identified.

To make the TM-Biocontrol-1 sprayable and to improve its effectiveness, several materials are mixed and added to the product for the final spray formulation. Composition of the sprayed formulation on a per acre basis was as follows:

TM-Biocontrol-1	$1X10^9$ activity units
Molasses*	0.25 gal.
Shade® (a sunscreen)	0.5 lb.
Water	0.72 gal.
Total	1.0 gal.

*50 gallons of formulation contained Sorbo as a replacement for molasses in the Los Alamos project.

C. Project Planning and Operations

1. Planning

During the month of September 1978, the Los Alamos and Bear Canyon areas were surveyed for Douglas-fir tussock moth egg

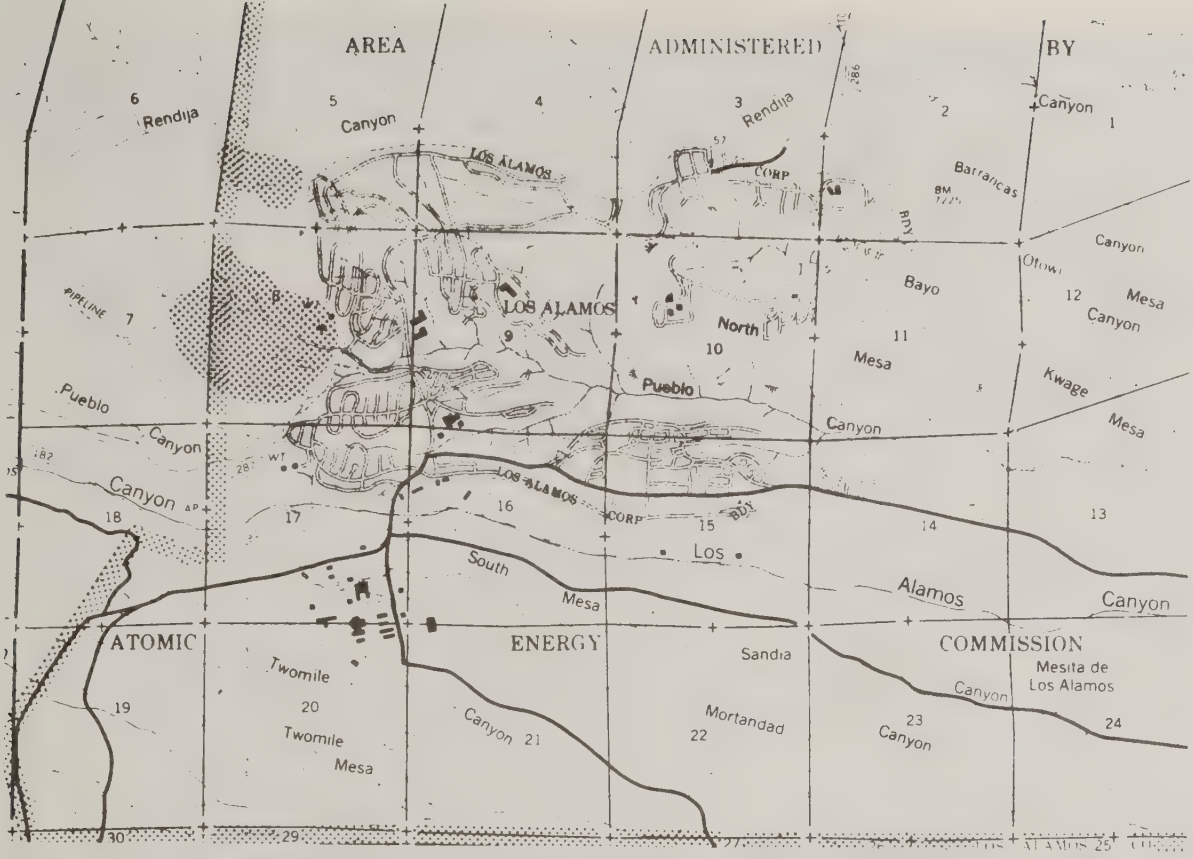

Fig. 1.--Location of Los Alamos DFTM-NPV treatment area, 1979.

Fig. 2.--Location of Bear Canyon DFTM-NPV treatment area, 1979.

masses, defoliation levels, and tree damages. Defoliation was estimated visually from the ground, and host trees were checked for the presence of egg masses and cocoons. The boundaries of the outbreaks were also delineated.

In October 1978, informational meetings were held with representatives from the Albuqueruqe Academy (administrators of the Ellena Gallegos Grant), the State Forestry Division of the Department of Natural Resources, the New Mexico Department of Agriculture, and the Santa Fe National Forest.

It was subsequently decided to evaluate the possiblity of conducting direct suppresssion programs against the tussock moth in these areas; environmental assessments were developed for both of the areas, and work plans were prepared to implement the treatment decision.

Several planning sessions were held to coordinate the project preparation, and news and radio releases were made to inform and involve the public.

2. Personnel

Personnel from the Forest Insect and Disease Management Staff Unit, State and Private Forestry, Albuquerque, New Mexico, administered the Santa Fe National Forest project, with members of the Santa Fe National Forest providing support. The Bear Canyon project was a cooperative undertaking between the Forestry Division of the New Mexico Department of Natural Resources, the New Mexico Department of Agriculture, administrators of the Ellena Gallegos Grant, and the USDA Forest Service. Additional assistance was provided by the Methods Application Group, Davis, California, and by the west-wide pesticide specialist.

3. Application

a. Aircraft. A Marsh Turbo Thrush S2R-T (Rockwell Thrush Commander equipped with a Garrett AiResearch TPE-331 Turbo Prop) applied the spray mixture to the treatment area.

(1) Designated Operating Parameters

	Santa Fe NF	Bear Canyon
Aircraft speed	150 m.p.h.	150 m.p.h.
Swath width	150 feet	100 feet
Boom spray pressure	40 p.s.i.	30 p.s.i.
Application rate	1 gal./acre	1 gal./acre
Release height above canopy	50 feet	50 feet

Figure 3.--Marsh Turbo Thrush S2R-T piloted by Bill Walker, Jr. over Santa Fe National Forest, Los Alamos Douglas-fir Tussock Moth Control Project, 1979.

(2) Spray System

Tank - 400 gal. capacity
Pump - 2-inch hydraulic root spray pump
Strainer - an approximately 50-mesh strainer was located between the pump and boom.
Boom - underwing mounted aluminum airfoil boom.

(3) Nozzles and Tips

	Santa Fe NF	Bear Canyon
Number	19	22
Nozzles	SS Tee Jet diaphragm; check valve nozzles	SS Tee Jet diaphragm; check valve nozzles
Tips	SS 8020 flat fan spray tips	SS 8015 flat fan spray tips
Strainers	Tee Jet 45 14-32 slotted strainers	Tee Jet 45 14-32 slotted strainers
Orientation	45 degrees down and back	45 degrees down and back
Placement	See Fig. 4	See Fig. 5

b. Application Rate. The NPV was applied at the rate of $1X10^9$ activity units in 1 gallon of finished spray per acre.

c. Calibration and Atomization Check. On June 12, 1979, 50 gallons of spray formulation, less virus, was prepared. The aircraft was calibrated to apply 1 gallon of the tank mix per acre and instructed to fly across a card line at 150 m.p.h. and 50 feet above the ground. Three separate runs were made and a field estimate of volume median diameter (VMD) calculated. Following a field check of the atomization produced in the Bear Canyon project, SS 8015 spray tips were replaced with SS 8020 tips in an effort to increase droplet size.

d. Mixing and Handling Equipment. A high speed electric stirring paddle was used to agitate a small batch of prepared tank mix in a 55-gallon drum. The virus preparation was brought into suspension by addition of the TM-Biocontrol-1 to the contents of the drum while agitation was maintained. This suspension was added to a 250-gallon slurry mixer.

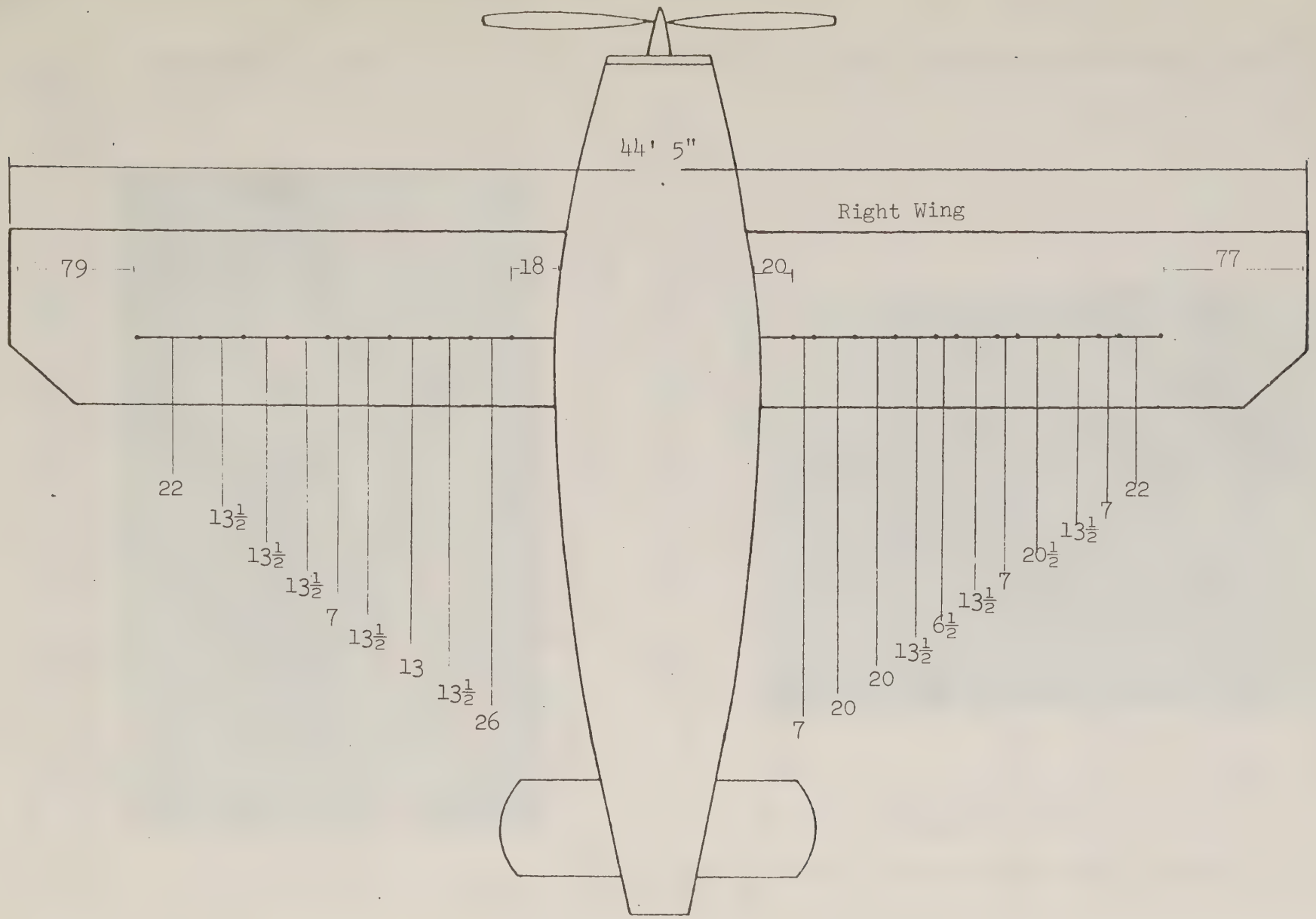

Fig. 4. Spacing of nozzles (in inches) on underwing airfoil boom, Los Alamos DFTM project, 1979.

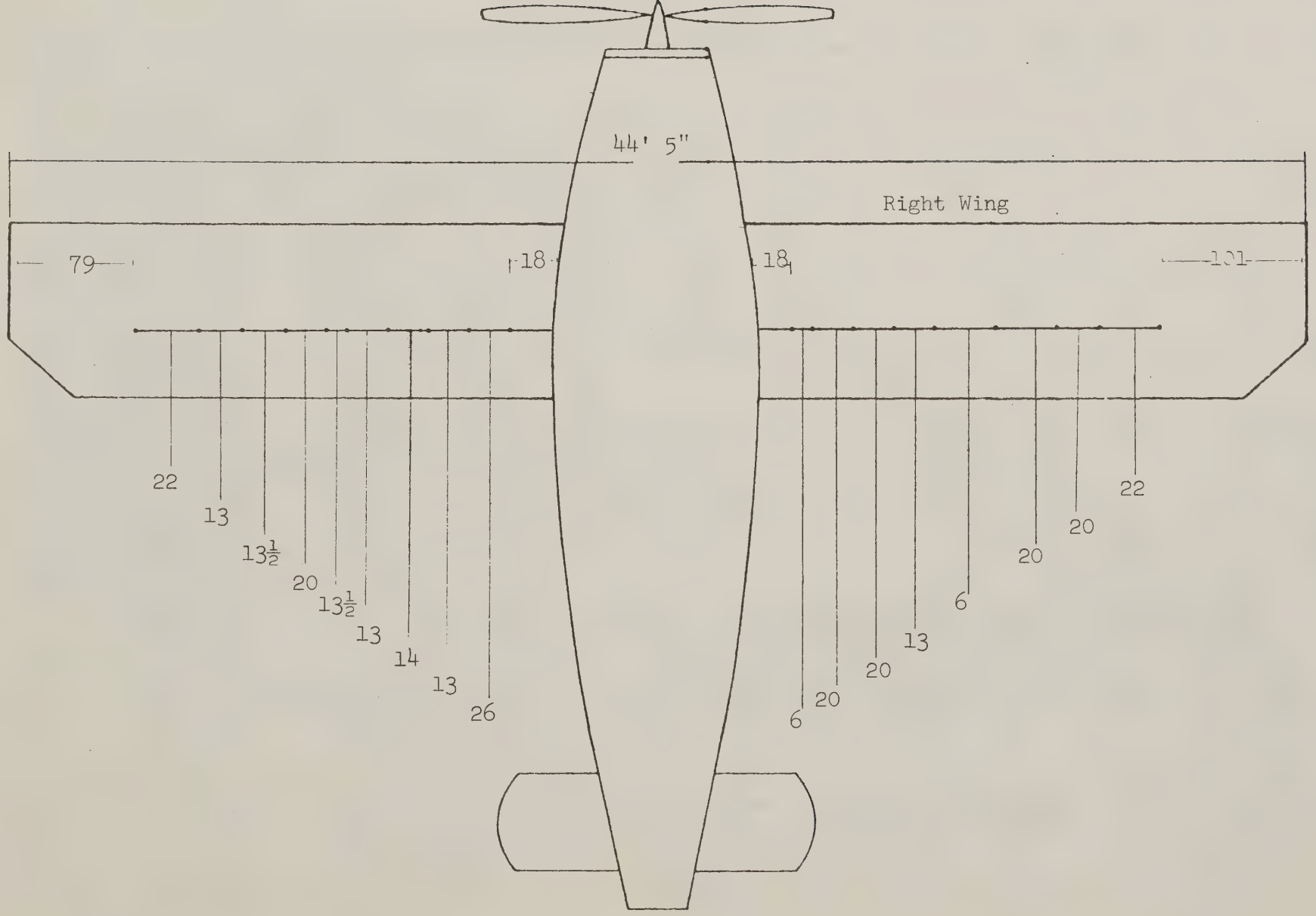

Fig. 5. Spacing of nozzles (in inches) on underwing airfoil boom, Bear Canyon DFTM project, 1979.

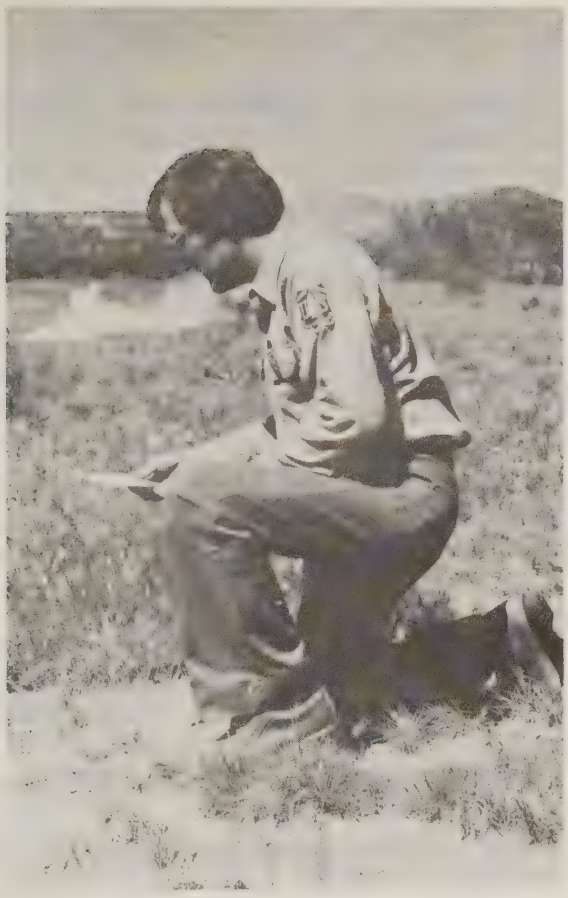

Figure 6.--Checking atomization on spray deposit cards, Los Alamos Douglas-fir Tussock Moth Control Project, 1979.

Figure 7.--Spraying system flat fan nozzle used in Los Alamos Douglas-fir Tussock Moth Control Project, 1979.

A 250-gallon slurry mixer with both a mechanical paddle and recirculation for agitation was used to prepare 200-gallon batches of the spray formulation. Separate gasoline engines were used to drive the mechanical paddle and to recirculate or pump the formulation from the mixing tank. Prepared formulation was transferred to a 1,000-gallon tanker for storage before transfer to the spray aircraft.

The pump on the tanker was plumbed to transfer to the spray aircraft or to recirculate back to the mixing tank, through a meter and an in-line filter.

e. Formulation and Mixing. All mixing was done in 200-gallon batches. For a 200-gallon batch, each ingredient was added in the following order and amount:

(1) Water, 144 gallons (72%)
(2) Shade® (IMC 90001, 100 pounds (3%)
(3) Molasses, 50 gallons (25%)
(4) TM-Biocontrol-1, 1910 grams

The following mixing procedure was used:

(1) Metered in 144 gallons of water.

(2) Slowly added 100 pounds of Shade® from four pails, while water was agitated and recirculated violently. Continued agitation for 30 minutes.

(3) Using a hydraulic hoist mounted on a pickup truck bed to lift the drum, added 50-gallons of molasses from a 55-gallon drum and mixed for 5 minutes.

(4) Transferred approximately 30 gallons of tank mix into an open 55-gallon drum. Slowly added 7,640 grams of TM-Biocontrol-1 into the 55-gallon drum while content was agitated.

(5) After thorough mixing, transferred the NPV mix into the slurry mixer. This was mixed for 10 minutes, after which contents of the slurry tanker were transferred to the large mixing tanker compartment.

(6) Steps 1, 2, and 3 were repeated for the next three batches, each batch being pumped into the vigorously recirculating mixture in the tanker. The entire mixture was recirculated vigorously for 30 minutes. Immediately before transferring the formulation to the aircraft, the mixture was again recirculated.

f. Spray Deposit Assessment. Spray deposit samplers, consisting of white Kromekote® cards, were used to monitor spray deposition. A card was placed at each cardinal direction under the drip line of trees sampled for DFTM larvae; cards were also positioned

in open areas to estimate the amount of spray reaching the ground unfiltered by the forest canopy. No dye was added to the spray, since the molasses and Shade® made the drop stains sufficiently dark.

All spray deposit cards were read using a Quantimet image analyzer located at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

g. Weather Forecasting and Meteorological Monitoring. The meteorologist in charge of the Albuquerque Weather Forecast Office, National Weather Service, provided a daily synoptic forecast to the project meteorologist.

Weather was favorable June 13 and 15 during aerial spraying.

h. Orientation of Spray Aircraft. A Hiller UH-12E J3 helicopter with an aerial observer was used to direct the spray aircraft during the spray operations.

D. Entomological Plan

1. Developmental Sampling

In New Mexico, initial egg hatch usually occurs near 220 degree-days accumulated from May 1. Degree-days were calculated as follows:

$$\frac{\text{MAX. DAILY}^\circ + \text{MIN. DAILY}^\circ}{2} - 42^\circ \text{ F}$$

After initial egg hatch, randomly selected egg masses were examined for hatch and dispersal. Depending on weather, first instar larvae disperse to new foliage within 1 or 2 days. Treatment was to begin within 72 hours following the apparent dispersal.

2. Larval Population Sampling

Branch samples for larval population counts were taken with a pole pruner equipped with an attached basket. Two 18-inch (minimum length) midcrown branches were pruned at each sample period from opposite sides of the tree in Bear Canyon; three were taken in Los Alamos. Branch length and width were measured and the number of DFTM larvae counted. Measurements were expressed as the number of larvae/1,000 $in.^2$ foliage. Larval populations were sampled within 48 hours pre-treatment, at 34 days post-treatment in Los Alamos, and at 21, 34, 42, and 49 days post-treatment in Bear Canyon.

Larval sampling was done on 25 trees in both Los Alamos and Bear Canyon. Sample trees were 30 to 50 feet in height, open-grown, and had sufficient foliage for the samples from midcrown.

IV. RESULTS

A. Timing of Application

Timing of the application was based on: 1) complete egg hatch and 2) dispersal of first instar larvae from egg masses.

Initial egg hatch occurred on May 29 (273 degree-days) in Los Alamos and on May 22 (175 degree-days) in Bear Canyon. Not until 20 days later, on June 11, was dispersal virtually complete in Bear Canyon. Egg hatch and dispersal were extremely slow in Los Alamos and were not 100 percent finished by June 15 when operational considerations dictated that the area be treated.

B. Spray Assessment

Recovery rates in the Los Alamos area and Bear Canyon were somewhat low. Spray cards in Bear Canyon received an average 0.19 gallon per acre, while the Los Alamos cards had an average 0.11 gallon per acre deposit. The volume median diameters were 199 μm and 192 μm, respectively.

The atomization produced in both treatment areas was considered acceptable, with a ratio of volume median diameter to number median diameter of 3.06 for Bear Canyon and 2.90 for Los Alamos.

Detailed results are shown in Tables 3, 4, and 5.

C. Population Reduction

Aerial treatment with the NPV in Bear Canyon and Los Alamos successfully reduced the tussock moth populations to an acceptable level in both areas. This is especially significant because the NPV was effective in both high (Bear Canyon) and low (Los Alamos) populations, and because the NPV was effective even though egg hatch and larval dispersal were not 100 percent complete at the time of application.

Thirty-four day post-treatment larval population reductions were 93 and 82 percent for Bear Canyon and Los Alamos, respectively. Larval densities and mortalities for the treated areas are given in Tables 6 and 7.

D. Operational Considerations

No significant operational problems were encountered during the projects.

This was the first use of a fixed-wing, turbine-powered aircraft to apply a pesticide to forests on an operational basis. The steepness and elevation of the terrain provided a maximum challenge to the aircraft and pilot.

The use of large orifice nozzles with slotted strainers eliminated the nozzle clogging experienced in the 1978 Douglas-fir tussock moth NPV pilot project. However, the mixing procedure is much too lengthy and complicated to be used in projects much larger than those described in this report. The development of a satisfactory mixing system is essential to make the NPV fully operational.

V. CONCLUSIONS

The Douglas-fir tussock moth nucleopolyhedrosis virus registered by the USDA Forest Service performed exceptionally well in this, its first use in an operational suppression project. Larval populations were reduced to very low levels in both the Ellena Gallegos Grant and Santa Fe National Forest treatment areas.

Performance of the Marsh Turbo Thrush S2R-T in high elevation, steep, mountainous terrain was excellent.

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ACKNOWLEDGEMENTS

We wish to thank all those from the Santa Fe National Forest, the New Mexico Department of Agriculture, and the New Mexico Department of Natural Resources, who contributed their time and effort to make these projects successful.

We also wish to extend our appreciation for the coordination efforts of the Department of Energy personnel in Los Alamos, New Mexico.

APPENDIX

Table 1
Organization Chart
Bear Canyon NPV Project, 1979

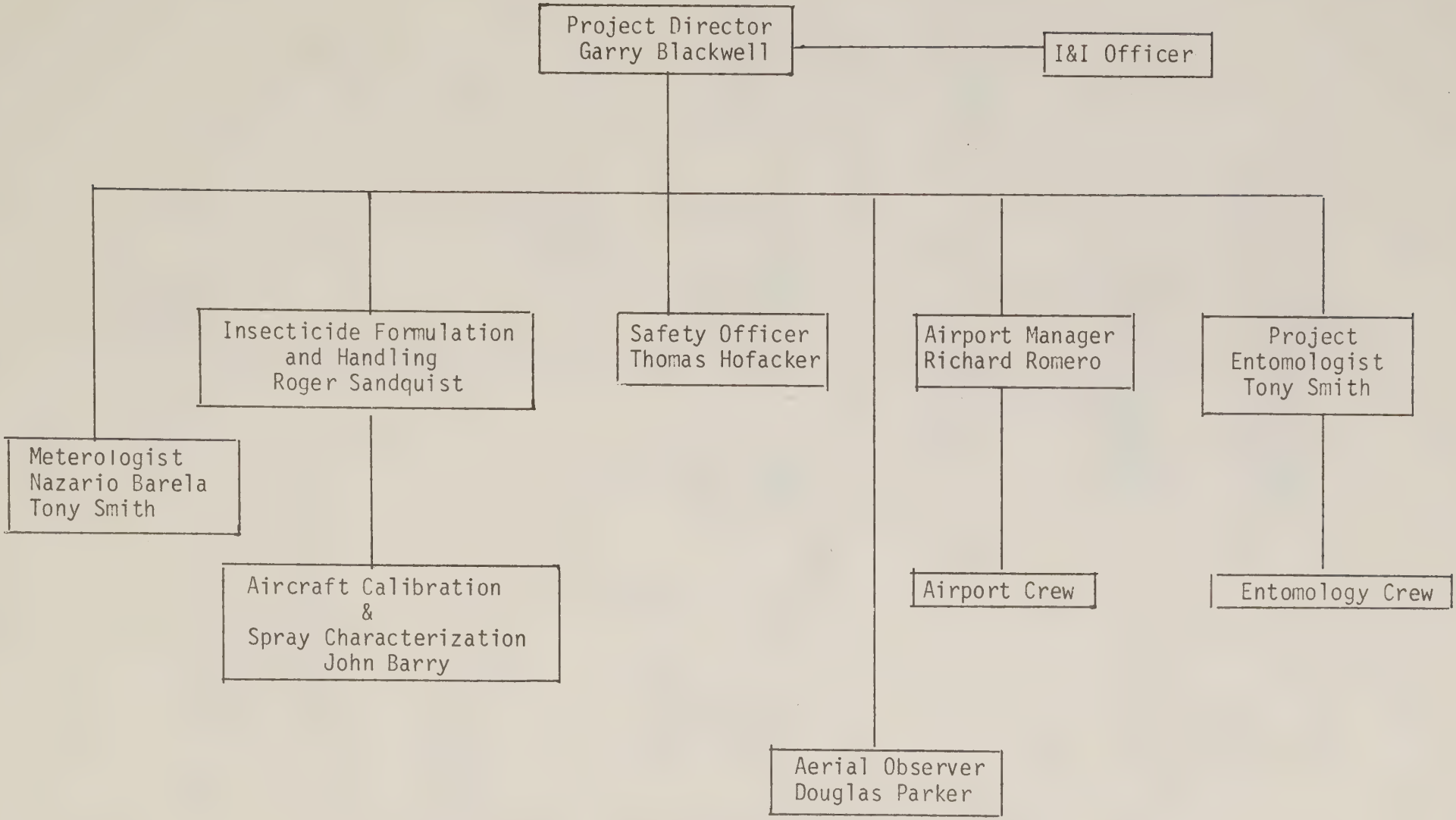

Table 2

Organization Chart
Los Alamos NPV Project, 1979

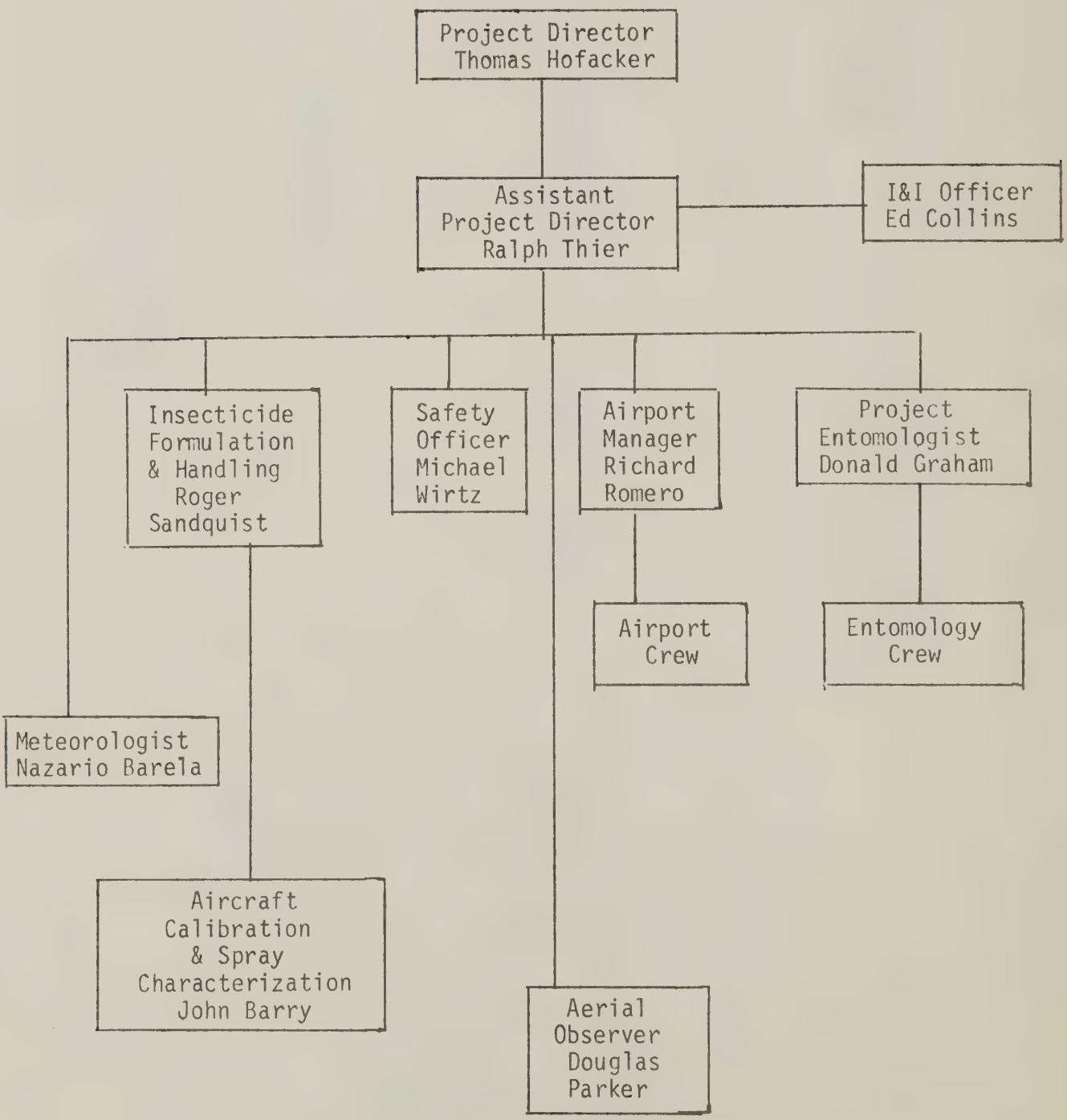

Table 3

Spray Deposit Data Summary
NPV Spray Projects, 1979

Measurement	Los Alamos	Bear Canyon
Volume Median Diameter (μm)	192	199
Volume Mean Diameter (μm)	212	209
Number Median Diameter (μm)	66	65
Number Mean Diameter (μm)	82	83
Drops/cm^2	10	18
Gallons/acre	0.108	0.197

Table 4. Spray deposit summary by sample tree, Bear Canyon, R-3, 1979, DFTM control project, June 12, 1979.

Tree	Droplet Diameter (μm) Mass Median	Mass Mean	Number Median	Number Mean	Drops/ cm^2	Gallons/ Acre
2	158	161	67	81	27	0.211
3	151	165	67	80	20	0.157
4	166	179	60	73	15	0.105
5	172	181	62	75	17	0.130
6	206	202	63	83	14	0.158
7	211	216	67	90	10	0.143
8	226	228	72	94	14	0.227
9	182	256	71	86	26	0.288
10	204	198	64	83	20	0.220
11	222	229	63	84	20	0.270
12	214	211	62	81	20	0.225
13	188	199	66	85	18	0.200
14	205	205	70	91	27	0.366
15	170	181	72	87	24	0.245
16	199	205	73	94	34	0.484
17	205	206	84	102	27	0.459
18	235	233	71	97	13	0.248
19	126	138	56	68	10	0.047
20	124	133	59	69	15	0.069
21	129	146	63	73	13	0.072
22	242	237	61	74	8	0.070
23	172	200	58	74	9	0.067
24	285	271	57	85	12	0.226
25	237	249	55	69	17	0.129

Table 5. Spray deposit summary for sample units, Los Alamos, R-3, control project, June 14, 1979.

Tree	Droplet Diameter (μm) Mass Median	Mass Mean	Number Median	Number Mean	Drops/ cm^2	Gallons/ Acre
3	130	143	70	80	9	0.062
4	107	109	55	64	8	0.028
5	129	190	70	79	10	0.070
6	148	158	73	85	10	0.081
7	155	170	63	76	21	0.153
8	147	148	67	80	8	0.061
9	129	139	73	83	7	0.051
10	134	137	46	59	4	0.012
11	175	194	71	86	11	0.112
12	228	223	50	74	3	0.028
13	95	99	47	54	4	0.007
14	122	132	65	75	5	0.027
15	137	156	71	82	2	0.016
16	174	182	74	89	4	0.041
17	252	249	101	126	6	0.211
18	138	151	60	72	6	0.034
19	123	133	53	65	5	0.021
20	151	158	57	69	15	0.087
21	255	242	57	73	13	0.123
22	215	212	70	91	19	0.264
23	196	190	61	77	7	0.063
24	155	169	58	69	7	0.041
25	135	136	58	70	6	0.032
26	188	198	66	83	10	0.106
27	343	334	52	93	2	0.051
28*	238	256	75	97	24	0.427

*Sample #28 consisted of 15 samples.

Table 6
Prespray and Postspray Douglas-fir
Tussock Moth Larval Densities,
Santa Fe NF and Ellena Gallegos Grant, 1979

Treatment Area	Prespray Larval Density (#/1,000 in.^{2})		21 Day Postspray Larval Density (#/1,000 in.^{2})		34 Day Postspray Larval Density (#/1,000 in.^{2})		42 Day Postspray Larval Density (#/1,000 in.^{2})		49 Day Postspray Larval Density (#/1,000 in.^{2})	
	Mean	SE*	Mean	SE*	Mean	SE*	Mean	SE*	Mean	SE*
Santa Fe NF	4.49	1.39	---	---	.83	.37	---	---	---	---
Ellena Gallegos Grant	203.79	15.93	88.18	14.37	15.07[1/]	1.42[1/]	4.40	.63	.69	.09

1/ Based on five tree sample. *Standard error.

Table 7
Douglas-fir Tussock Moth Larval Population
Reduction, Santa Fe NF
and Ellena Gallegos Grant, 1979

Treatment Acres	PERCENT LARVAL REDUCTION			
	21 Day Postspray	34 Day Postspray	42 Day Postspray	49 Day Postspray
Santa Fe NF	---	82	---	---
Ellena Gallegos Grant	65	93	98	99.66

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to man, animals, and plants. Follow directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.